

## Features

- Fast Read Access Time - 120 ns
- Word-wide or Byte-wide Configurable
- Dual Voltage Range Operation
  - Unregulated Battery Power Supply Range, 2.7V to 3.6V
  - or Standard 5V  $\pm$  10% Supply Range
- 4-Megabit Flash and Mask ROM Compatible
- Low Power CMOS Operation
  - 20  $\mu$ A Maximum Standby
  - 10 mA Max. Active at 5 MHz for  $V_{CC} = 3.6V$
- JEDEC Standard Packages
  - 44-Lead PLCC
  - 44-Lead SOIC (SOP)
  - 48-Lead TSOP (12 mm x 20 mm)
- High Reliability CMOS Technology
  - 2,000 ESD Protection
  - 200 mA Latchup Immunity
- Rapid™ Programming Algorithm - 50  $\mu$ s/word (typical)
- CMOS and TTL Compatible Inputs and Outputs
  - JEDEC Standard for LVTTTL and LVBO
- Integrated Product Identification Code
- Commercial and Industrial Temperature Ranges

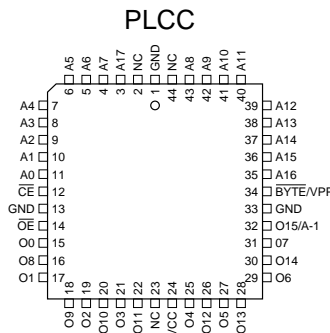
## Description

The AT27BV400 is a high performance low-power, low-voltage 4,194,304-bit one time programmable read only memory (OTP EPROM) organized as either 256K by 16 or 512K by 8 bits. It requires only one supply in the range of 2.7 to 3.6V in normal read

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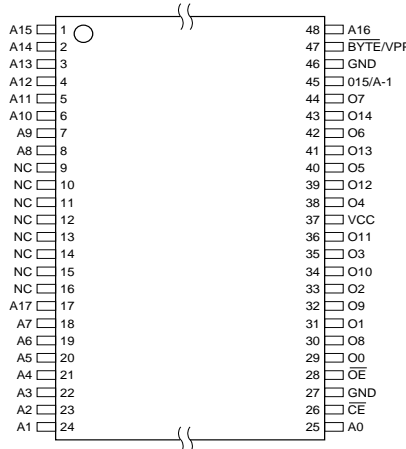
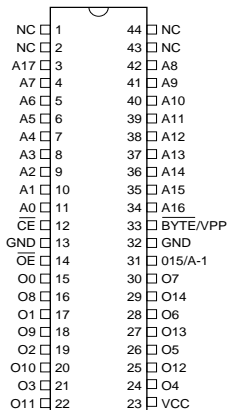
## Pin Configurations

Pin Name	Function
A0 - A17	Addresses
O0 - O15	Outputs
O15/A-1	Output/Address
$\overline{\text{BYTE}}/V_{PP}$	Byte Mode/ Program Supply
$\overline{\text{CE}}$	Chip Enable
$\overline{\text{OE}}$	Output Enable
NC	No Connect



TSOP  
Type 1

SOIC (SOP)



**4-Megabit  
(256K x 16 or  
512K x 8)  
Unregulated  
Battery-Voltage™  
High Speed  
OTP EPROM**

**AT27BV400  
Preliminary**





mode operation. The by-16 organization makes this part ideal for portable and hand held 16- and 32-bit microprocessor systems using either regulated or unregulated battery power.

Atmel's innovative design techniques provide fast speeds that rival 5V parts while keeping the low power consumption of a 3V supply. At  $V_{CC} = 2.7V$ , any word can be accessed in less than 120ns. With a typical power dissipation of only 10 mW at 5mHZ and  $V_{CC} = 3V$ , the AT27BV400 consumes less than one fifth the power of a standard 5V EPROM.

Standby mode supply current is typically less than 1 mA at 3V. The AT27BV400 simplifies system design and stretches battery lifetime even further by eliminating the need for power supply regulation.

The AT27BV400 can be organized as either word-wide or byte-wide. The organization is selected via the  $\overline{BYTE}/V_{PP}$  pin. When  $\overline{BYTE}/V_{PP}$  is asserted high ( $V_{IH}$ ), the word-wide organization is selected and the O15/A-1 pin is used for O15 data output. When  $\overline{BYTE}/V_{PP}$  is asserted low ( $V_{IL}$ ), the byte wide organization is selected and the O15/A-1 pin is used for the address pin A-1. When the AT27BV400 is logically regarded as x16 (word-wide), but read in the byte-wide mode, then with  $A-1 = V_{IL}$  the lower 8 bits of the 16-bit word are selected with  $A-1 = V_{IH}$  the upper 8 bits of the 16-bit word are selected.

The AT27BV400 is available in industry standard JEDEC-approved one-time programmable (OTP) PLCC, SOIC (SOP), and TSOP packages. The device features two-line control ( $\overline{CE}, \overline{OE}$ ) to eliminate bus contention.

With high density 256K word or 512K byte storage capability, the AT27BV400 allows firmware to be stored reliably and to be accessed by the system without the delays of mass storage media.

The AT27BV400 operating with  $V_{CC}$  at 3.0V produces TTL level outputs that are compatible with standard TTL logic

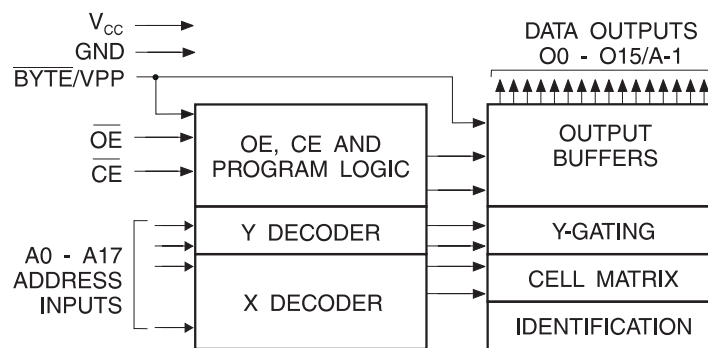
devices operating at  $V_{CC} = 5V$ . At  $V_{CC} = 2.7V$ , the part is compatible with JEDEC approved low voltage battery operation (LVBO) interface specifications. The device is also capable of standard 5-volt operation making it ideally suited for dual supply range systems or card products that are pluggable in both 3-volt and 5-volt hosts.

Atmel's AT27BV400 has additional features that ensure high quality and efficient production use. The Rapid™ Programming Algorithm reduces the time required to program the part and guarantees reliable programming. Programming time is typically only 50µs/word. The Integrated Product Identification Code electronically identifies the device and manufacturer. This feature is used by industry standard programming equipment to select the proper programming equipment and voltages. The AT27BV400 programs exactly the same way as a standard 5V AT27C400 and uses the same programming equipment.

## System Considerations

Switching between active and standby conditions via the Chip Enable pin may produce transient voltage excursions. Unless accommodated by the system design, these transients may exceed data sheet limits, resulting in device non-conformance. At a minimum, a 0.1 µF high frequency, low inherent inductance, ceramic capacitor should be utilized for each device. This capacitor should be connected between the  $V_{CC}$  and Ground terminals of the device, as close to the device as possible. Additionally, to stabilize the supply voltage level on printed circuit boards with large EPROM arrays, a 4.7 µF bulk electrolytic capacitor should be utilized, again connected between the  $V_{CC}$  and Ground terminals. This capacitor should be positioned as close as possible to the point where the power supply is connected to the array.

## Block Diagram



## Absolute Maximum Ratings\*

Temperature Under Bias .....	-55°C to +125°C
Storage Temperature .....	-65°C to +150°C
Voltage on Any Pin with with Respect to Ground .....	-2.0V to +7.0V <sup>(1)</sup>
Voltage on A9 with Respect to Ground .....	-2.0V to +14.0V <sup>(1)</sup>
V <sub>PP</sub> Supply Voltage with Respect to Ground .....	-2.0V to +14.0V <sup>(1)</sup>

\*NOTICE: Stresses beyond those listed under “Absolute Maximum Ratings” may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions beyond those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Note: 1. Minimum voltage is -0.6V DC which undershoot to -2.0V for pulses of less than 20 ns. Maximum output pin voltage is V<sub>CC</sub> + 0.75V DC which may overshoot to + 7.0V for pulses of less than 20 ns.

## Operating Modes

Mode/Pin	$\overline{CE}$	$\overline{OE}$	Ai	$\overline{BYTE}/V_{PP}$	Outputs		
					O <sub>0</sub> -O <sub>7</sub>	O <sub>8</sub> -O <sub>14</sub>	O <sub>15</sub> /A-1
Read Word-wide	V <sub>IL</sub>	V <sub>IL</sub>	X <sup>(1)</sup>	V <sub>IH</sub>	D <sub>OUT</sub>	D <sub>OUT</sub>	D <sub>OUT</sub>
Read Byte-wide Upper	V <sub>IL</sub>	V <sub>IL</sub>	X <sup>(1)</sup>	V <sub>IL</sub>	D <sub>OUT</sub>	High Z	V <sub>IH</sub>
Read Byte-wide Lower	V <sub>IL</sub>	V <sub>IL</sub>	X <sup>(1)</sup>	V <sub>IL</sub>	D <sub>OUT</sub>	High Z	V <sub>IL</sub>
Output Disable	X <sup>(1)</sup>	V <sub>IH</sub>	X <sup>(1)</sup>	X		High Z	
Standby	V <sub>IH</sub>	X <sup>(1)</sup>	X <sup>(1)</sup>	X <sup>(6)</sup>		High Z	
Rapid Program <sup>(3)</sup>	V <sub>IL</sub>	V <sub>IH</sub>	Ai	V <sub>PP</sub>		D <sub>IN</sub>	
PGM Verify	X	V <sub>IL</sub>	Ai	V <sub>PP</sub>		D <sub>OUT</sub>	
PGM Inhibit	V <sub>IH</sub>	V <sub>IH</sub>	X <sup>(1)</sup>	V <sub>PP</sub>		High Z	
Product Identification <sup>(5)</sup>	V <sub>IL</sub>	V <sub>IL</sub>	A9 = V <sub>H</sub> <sup>(4)</sup> A0 = V <sub>IH</sub> or V <sub>IL</sub> A1 - A17 = V <sub>IL</sub>	V <sub>IH</sub>	Identification Code		

- Notes:
1. X can be V<sub>IL</sub> or V<sub>IH</sub>.
  2. Read, output disable, and standby modes require, 2.7V ≤ V<sub>CC</sub> ≤ 3.6V, or 4.5V ≤ V<sub>CC</sub> ≤ 5.5V.
  3. Refer to the programming characteristics tables in this data sheet.
  4. V<sub>H</sub> = 12.0 ± 0.5V.
  5. Two identifier words may be selected. All Ai inputs are held low (V<sub>IL</sub>) except A9, which is set to V<sub>H</sub>, and A0, which is toggled low (V<sub>IL</sub>) to select the Manufacturer's Identification word and high (V<sub>IH</sub>) to select the Device Code word.
  6. Standby V<sub>CC</sub> current (I<sub>SB</sub>) is specified with V<sub>PP</sub> = V<sub>CC</sub>. V<sub>CC</sub> > V<sub>PP</sub> will cause a slight increase in I<sub>SB</sub>.



## DC and AC Operating Conditions for Read Operation

		AT27BV400	
		-12	-15
Operating Temperature (Case)	Com.	0°C - 70°C	0°C - 70°C
	Ind.	-40°C - 85°C	-40°C - 85°C
V <sub>CC</sub> Power Supply		2.7V to 3.6V	2.7V to 3.6V
		5V ± 10%	5V ± 10%

## DC and Operating Characteristics for Read Operation

Symbol	Parameter	Condition	Min	Max	Units
<b>V<sub>CC</sub> = 2.7V to 3.6V</b>					
I <sub>LI</sub>	Input Load Current	V <sub>IN</sub> = 0V to V <sub>CC</sub>		±1	μA
I <sub>LO</sub>	Output Leakage Current	V <sub>OUT</sub> = 0V to V <sub>CC</sub>		±5	μA
I <sub>PP1</sub> <sup>(2)</sup>	V <sub>PP</sub> <sup>(1)</sup> Read/Standby Current	V <sub>PP</sub> = V <sub>CC</sub>		10	μA
I <sub>SB</sub>	V <sub>CC</sub> <sup>(1)</sup> Standby Current	I <sub>SB1</sub> (CMOS), $\overline{CE} = V_{CC} \pm 0.3V$		20	μA
		I <sub>SB2</sub> (TTL), $\overline{CE} = 2.0$ to V <sub>CC</sub> + 0.5V		100	μA
I <sub>CC</sub>	V <sub>CC</sub> Active Current	f = 5MHz, I <sub>OUT</sub> = 0 mA, $\overline{CE} = V_{IL}$ , V <sub>CC</sub> = 3.6V		10	mA
V <sub>IL</sub>	Input Low Voltage	V <sub>CC</sub> = 3.0 to 3.6V	-0.6	0.8	V
		V <sub>CC</sub> = 2.7 to 3.6V	-0.6	0.2 x V <sub>CC</sub>	V
V <sub>IH</sub>	Input High Voltage	V <sub>CC</sub> = 3.0 to 3.6V	2.0	V <sub>CC</sub> + 0.5	V
		V <sub>CC</sub> = 2.7 to 3.6V	0.7 x V <sub>CC</sub>	V <sub>CC</sub> + 0.5	V
V <sub>OL</sub>	Output Low Voltage	I <sub>OL</sub> = 2.0 mA		0.4	V
		I <sub>OL</sub> = 100 μA		0.2	V
		I <sub>OL</sub> = 20 μA		0.1	V
V <sub>OH</sub>	Output High Voltage	I <sub>OH</sub> = -2.0 mA	2.4		V
		I <sub>OH</sub> = -100 μA	V <sub>CC</sub> - 0.2		V
		I <sub>OH</sub> = -20 μA	V <sub>CC</sub> - 0.1		V
<b>V<sub>CC</sub> = 4.5V to 5.5V</b>					
I <sub>LI</sub>	Input Load Current	V <sub>IN</sub> = 0V to V <sub>CC</sub>		±1	μA
I <sub>LO</sub>	Output Leakage Current	V <sub>OUT</sub> = 0V to V <sub>CC</sub>		±5	μA
I <sub>PP1</sub> <sup>(2)</sup>	V <sub>PP</sub> <sup>(1)</sup> Read/Standby Current	V <sub>PP</sub> = V <sub>CC</sub>		10	μA
I <sub>SB</sub>	V <sub>CC</sub> <sup>(1)</sup> Standby Current	I <sub>SB1</sub> (CMOS), $\overline{CE} = V_{CC} \pm 0.3V$		100	μA
		I <sub>SB2</sub> (TTL), $\overline{CE} = 2.0$ to V <sub>CC</sub> + 0.5V		1	mA
I <sub>CC</sub>	V <sub>CC</sub> Active Current	f = 5 MHz, I <sub>OUT</sub> = 0 mA, $\overline{CE} = V_{IL}$		40	mA
V <sub>IL</sub>	Input Low Voltage		-0.6	0.8	V
V <sub>IH</sub>	Input High Voltage		2.0	V <sub>CC</sub> + 0.5	V
V <sub>OL</sub>	Output Low Voltage	I <sub>OH</sub> = 2.1 mA		0.4	V
V <sub>OH</sub>	Output High Voltage	I <sub>OH</sub> = -400 μA	2.4		V

- Notes: 1. V<sub>CC</sub> must be applied simultaneously or before V<sub>PP</sub>, and removed simultaneously or after V<sub>PP</sub>.  
 2. V<sub>PP</sub> may be connected directly to V<sub>CC</sub> except during programming. The supply current would then be the sum of I<sub>CC</sub> and I<sub>PP</sub>

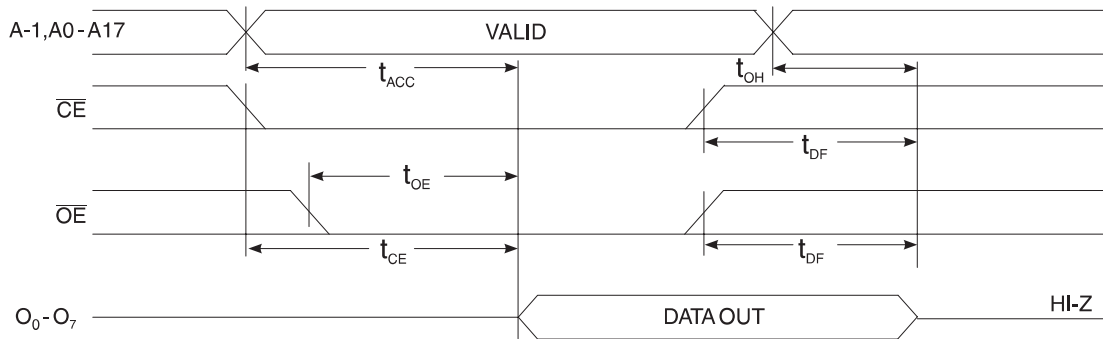
## AC Characteristics for Read Operation

$V_{CC} = 2.7V$  to  $3.6V$  and  $4.5V$  to  $5.5V$

Symbol	Parameter	Condition	AT27BV400				Units
			-12		-15		
			Min	Max	Min	Max	
$t_{ACC}^{(2)}$	Address to Output Delay	$\overline{CE} = \overline{OE} = V_{IL}$		120		150	ns
$t_{CE}^{(2)}$	$\overline{CE}$ to Output Delay	$\overline{OE} = V_{IL}$		120		150	ns
$t_{OE}^{(2)(3)}$	$\overline{OE}$ to Output Delay	$\overline{CE} = V_{IL}$		40		50	ns
$t_{DF}^{(4)(5)}$	$\overline{OE}$ or $\overline{CE}$ High to Output Float, whichever occurred first			30		35	ns
$t_{OH}^{(4)}$	Output Hold from Address $\overline{CE}$ or $\overline{OE}$ , whichever occurred first		5		5		ns
$t_{ST}$	$\overline{BYTE}$ High to Output Valid			120		150	ns
$t_{STD}$	$\overline{BYTE}$ Low to Output Transition			50		60	ns

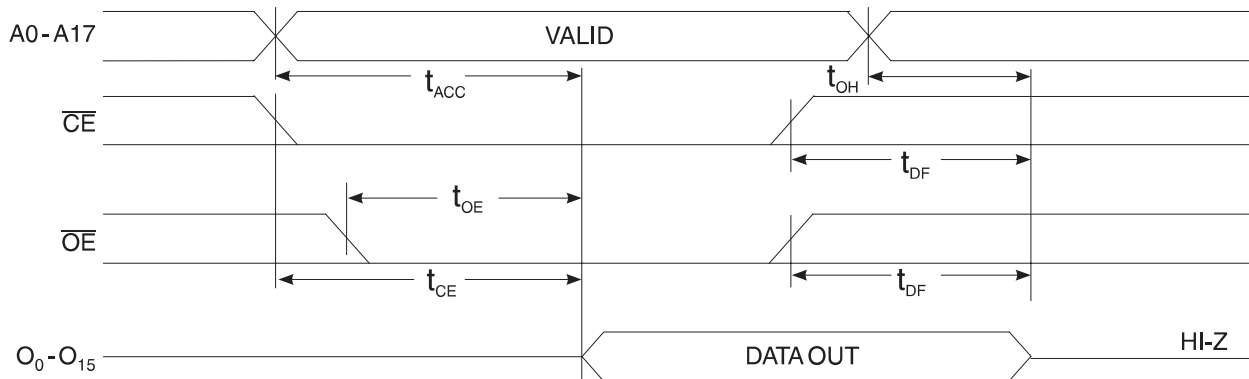
Notes: 1. 2,3,4,5. See the AC Waveforms for Read Operation diagram.

## Byte-Wide Read Mode AC Waveforms



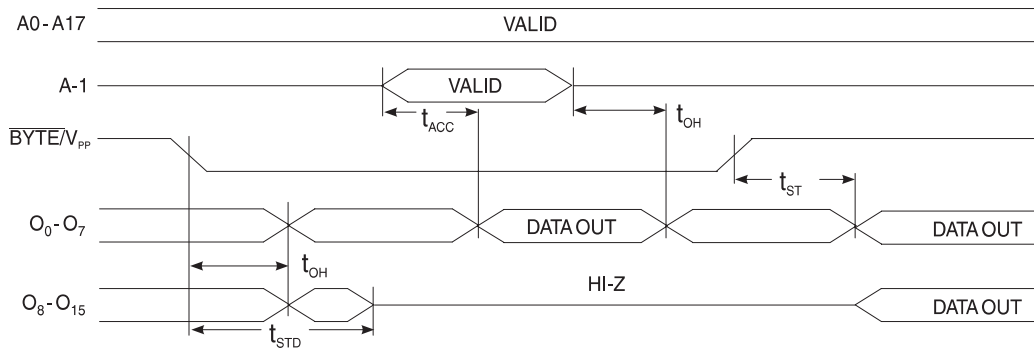
Note:  $\overline{BYTE}/V_{PP} = V_{IL}$

## Word-Wide Read Mode AC Waveforms



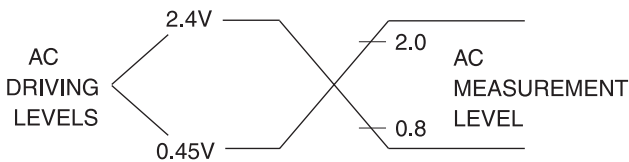
Note:  $\overline{BYTE}/V_{PP} = V_{IH}$

## BYTE Transition AC Waveforms



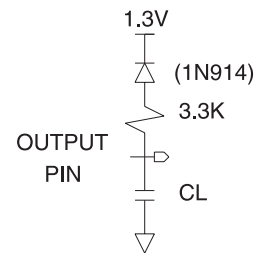
- Notes:
1. Timing measurement references are 0.8V and 2.0V. Input AC drive levels are 0.45V and 2.4V, unless otherwise specified.
  2.  $\overline{OE}$  may be delayed up to  $t_{CE} - t_{OE}$  after the falling edge of  $\overline{CE}$  without impact on  $t_{CE}$ .
  3.  $\overline{OE}$  may be delayed up to  $t_{ACC} - t_{OE}$  after the address is valid without impact on  $t_{ACC}$ .
  4. This parameter is only sampled and is not 100% tested.
  5. Output float is defined as the point when data is no longer driven.

## Input Test Waveforms and Measurement Levels



$t_R, t_F < 20$  ns (10% to 90%)

## Output Test Load



Note:  $C_L = 100$  pF including jig capacitance.

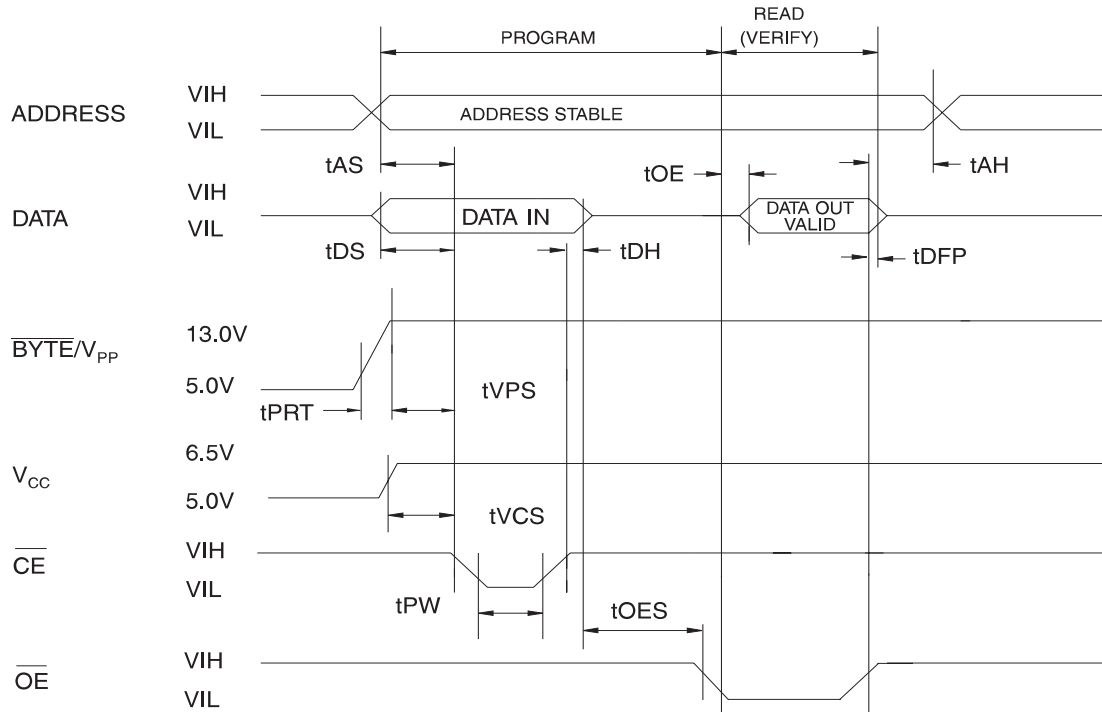
## Pin Capacitance

$f = 1$  MHz,  $T = 25^\circ\text{C}^{(1)}$

	Typ	Max	Units	Conditions
$C_{IN}$	4	10	pF	$V_{IN} = 0V$
$C_{OUT}$	8	12	pF	$V_{OUT} = 0V$

Note: 1. Typical values for nominal supply voltage. This parameter is only sampled and is not 100% tested.

## Programming Waveforms<sup>(1)</sup>



- Notes:
1. The Input Timing reference is 0.8V for  $V_{IL}$  and 2.0V for  $V_{IH}$ .
  2.  $t_{OE}$  and  $t_{DFP}$  are characteristics of the device but must be accommodated by the programmer.
  3. When programming the AT27BV400, a 0.1  $\mu\text{F}$  capacitor is required across  $V_{PP}$  and ground to suppress voltage transients.

## DC Programming Characteristics

$T_A = 25 \pm 5^\circ\text{C}$ ,  $V_{CC} = 6.5 \pm 0.25\text{V}$ ,  $V_{PP} = 13.0 \pm 0.25\text{V}$

Symbol	Parameter	Test Conditions	Limits		Units
			Min	Max	
$I_{LI}$	Input Load Current	$V_{IN} = V_{IL}, V_{IH}$		$\pm 10$	$\mu\text{A}$
$V_{IL}$	Input Low Level		-0.6	0.8	V
$V_{IH}$	Input High Level		2.0	$V_{CC} + 0.5$	V
$V_{OL}$	Output Low Voltage	$I_{OL} = 2.1 \text{ mA}$		0.4	V
$V_{OH}$	Output High Voltage	$I_{OH} = -400 \mu\text{A}$	2.4		V
$I_{CC2}$	$V_{CC}$ Supply Current (Program and Verify)			50	mA
$I_{PP2}$	$V_{PP}$ Supply Current	$\overline{CE} = V_{IL}$		30	mA
$V_{ID}$	A9 Product Identification Voltage		11.5	12.5	V

## AC Programming Characteristics

$T_A = 25 \pm 5^\circ\text{C}$ ,  $V_{CC} = 6.5 \pm 0.25\text{V}$ ,  $V_{PP} = 13.0 \pm 0.25\text{V}$

Symbol	Parameter	Test Conditions <sup>(1)</sup>	Limits		Units
			Min	Max	
$t_{AS}$	Address Setup Time	Input Rise and Fall Times: (10% to 90%) 20 ns	2		$\mu\text{s}$
$t_{OES}$	$\overline{OE}$ Setup Time		2		$\mu\text{s}$
$t_{DS}$	Data Setup Time		2		$\mu\text{s}$
$t_{AH}$	Address Hold Time	Input Pulse Levels: 0.45V to 2.4V	0		$\mu\text{s}$
$t_{DH}$	Data Hold Time		2		$\mu\text{s}$
$t_{DFP}$	$\overline{OE}$ High to Output Float Delay <sup>(2)</sup>	Input Timing Reference Level: 0.8V to 2.0V	0	130	ns
$t_{VPS}$	$V_{PP}$ Setup Time		2		$\mu\text{s}$
$t_{VCS}$	$V_{CC}$ Setup Time		2		$\mu\text{s}$
$t_{PW}$	$\overline{CE}$ Program Pulse Width <sup>(3)</sup>	Output Timing Reference Level: 0.8V to 2.0V	47.5	52.5	$\mu\text{s}$
$t_{OE}$	Data Valid from $\overline{OE}$			150	ns
$t_{PRT}$	$\overline{BYTE}$ / $V_{PP}$ Pulse Rise Time During Programming		50		ns

- Notes:
- $V_{CC}$  must be applied simultaneously or before  $V_{PP}$  and removed simultaneously or after  $V_{PP}$ .
  - This parameter is only sampled and is not 100% tested. Output Float is defined as the point where data is no longer driven—see timing diagram.
  - Program Pulse width tolerance is  $50 \mu\text{sec} \pm 5\%$ .

## Atmel's 27BV800 Integrated Product Identification Code<sup>(1)</sup>

Codes	Pins									Hex Data
	A0	O15	O14	O13	O12	O11	O10	O9	O8	
Manufacturer	0	0	0	0	1	1	1	1	0	1E1E
Device Type	1	1	1	1	1	0	1	0	0	F4F4

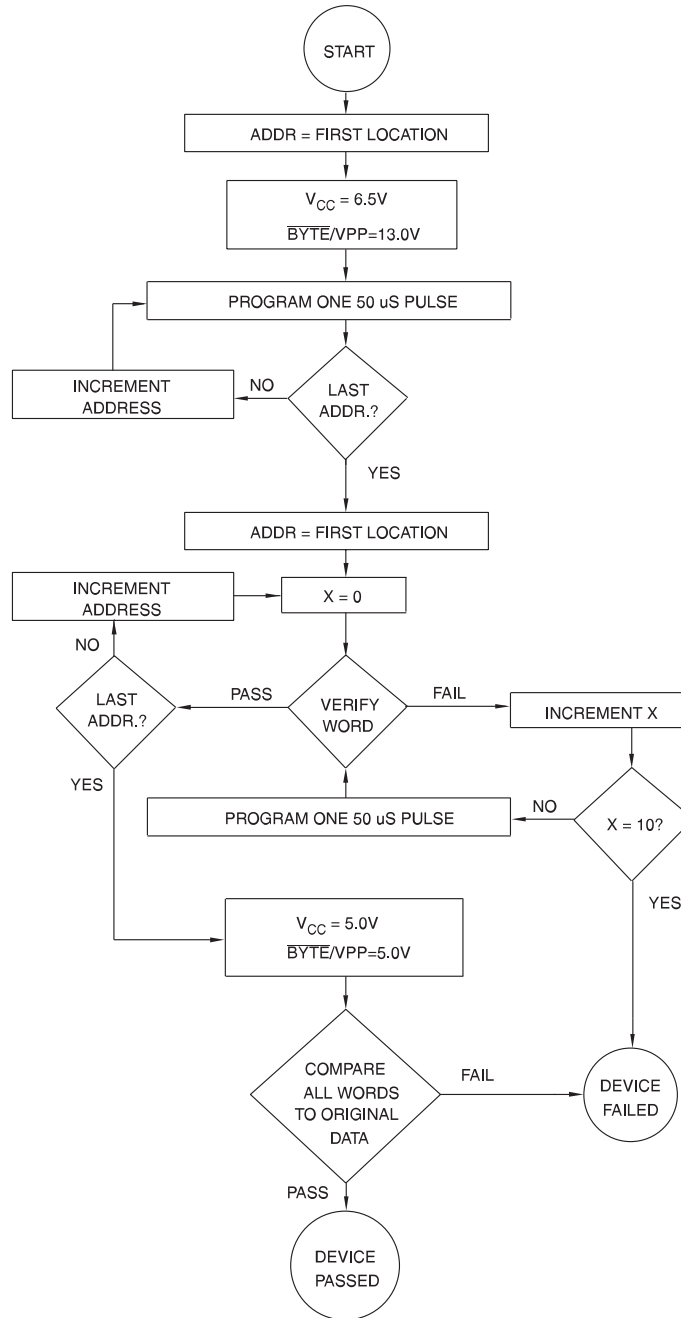
- Note:
- The AT27BV400 has the same Product Identification Code as the AT27C400. Both are programming compatible.



## Rapid Programming Algorithm

A 50  $\mu\text{s}$   $\overline{\text{CE}}$  pulse width is used to program. The address is set to the first location.  $V_{\text{CC}}$  is raised to 6.5V and  $\overline{\text{BYTE}}/V_{\text{PP}}$  is raised to 13.0V. Each address is first programmed with one 50  $\mu\text{s}$   $\overline{\text{CE}}$  pulse without verification. Then a verification/reprogramming loop is executed for each address. In the event a word fails to pass verification, up to 10 successive 50  $\mu\text{s}$  pulses are applied with a verification after each

pulse. If the word fails to verify after 10 pulses have been applied, the part is considered failed. After the word verifies properly, the next address is selected until all have been checked.  $V_{\text{PP}}$  is then lowered to 5.0V and  $V_{\text{CC}}$  to 5.0V. All words are read again and compared with the original data to determine if the device passes or fails.





## Ordering Information

$t_{ACC}$ (ns)	$I_{CC}$ (mA)		Ordering Code	Package	Operation Range
	Active	Standby			
120	10	0.02	AT27BV400-12JC AT27BV400-12RC AT27BV400-12TC	44J 44R 48T	Commercial (0°C to 70°C)
	10	0.02	AT27BV400-12JI AT27BV400-12RI AT27BV400-12TI	44J 44R 48T	Industrial (-40°C to 85°C)
150	10	0.02	AT27BV400-15JC AT27BV400-15RC AT27BV400-15TC	44J 44R 48T	Commercial (0°C to 70°C)
	10	0.02	AT27BV400-15JI AT27BV400-15RI AT27BV400-15TI	44J 44R 48T	Industrial (-40°C to 85°C)

Package Type	
<b>44J</b>	44-Lead, Plastic J-Leaded Chip Carrier (PLCC)
<b>44R</b>	44-Lead, 0.450" Wide, Plastic Gull Wing Small Outline Package (SOIC/SOP)
<b>48T</b>	48-Lead, Plastic Thin Small Outline Package (TSOP) 12 x 20 mm

